Independent Peer Review of the

Bering Sea and Aleutian Islands Atka Mackerel Assessment

Prepared by

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for

The Center for Independent Experts

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Bering Sea and Aleutian Islands Atka Mackerel Assessment

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Executive Summary

The Assessment Model for Alaska (AMAK) modelling approach, trawl survey program and observer program are all state of the art and have been successfully used to model fisheries in the Alaska area. However, it is time to reconsider how the Atka mackerel survey data are being interpreted along with the current model structure. Atka mackerel survey indices may not provide adequate estimates of stock biomass or biomass trends over time due to the difficulty in sampling these species with a bottom trawl. Changes in survey tow duration starting in 2002 may have resulted in a higher encounter rate for this species and may have resulted in an inconsistency in estimating the biomass over the complete time series. The current assessment also uses a weighted mean of the proportion of survey biomass by subarea over the last four surveys to apportion the TAC and thus relies on the survey providing unbiased estimates of relative biomass. The high quality landings data and catch-at-age composition data from the observer program may be providing the major source of trend information to the model. This will be an issue as the stock assessment models the population across all of the subareas while the catch information has become restricted in recent years to the eastern area and a portion of the central area due to area closures, and reductions in the central area catch to support steller sea lion recovery. It is recommended that the survey data be evaluated in terms of tow duration changes, survey design and the development of alternate estimation approaches possibly incorporating habitat information. This review also recommends that separate AMAK models be fit to each of the subareas (West, Central and East) to assess spatial variability in survey trends, selectivity for both survey and fishery and other parameters in the model. TAC recommendations from separate subarea models should be compared with those from the current approach to evaluate the influence of using the survey data proportions. Finally, the adequacy of the current approach to determining penalties for fitting the selectivities should be further evaluated to determine if the current fits are over-representing the degree of cohort targeting in the fishery. No detailed analysis of time or age-varying natural mortality was presented to the panel for review.

Background

The Center of Independent Experts (CIE) organized a review of the Bering Sea and Aleutian Islands Atka mackerel (*Pleurogrammus monopterygius*) stock assessment in Seattle at the request of the Alaska Fisheries Science Center (AFSC). In addition to supporting a valuable commercial fishery, Atka mackerel is a key prey species for several top trophic level consumers in the region, and in particular a dominant prey item for the endangered Steller sea lion. Current management measures designed to protect the sea lions include large area closures and reduction of directed fishing quotas. Reliable estimates of biomass and stock status are required to support and evaluate these measures. The last CIE review of this stock assessment was in 2008 and a number of changes have been made to the assessment model since then. Starting in 2008, the assessment had replaced the previously used time-varying selectivity with constant selectivity within four time blocks corresponding to different periods in the fishery. In the current assessment, time-varying selectivities for the fishery and the survey have been re-introduced with a new way of defining penalties.

Description of the Individual Reviewer's Role in the Review Activities

The current advice for this stock was not under review as the most recent stock assessment was completed and accepted in 2013, the 2014 fishing year is not yet complete and the survey in 2014 was still underway during the review. Instead, the review was focused on the input data, biological knowledge, stock assessment methodology, and harvest strategy for Atka mackerel. The last review by the CIE was held in 2008 (Francis, 2008; Parma, 2008; Trzcinski, 2008) and while changes recommended by that panel had been included in the 2008 and following assessments there have been other modifications made to the assessment since then. A large number of documents, including the chapter from the 2013 SAFE report detailing the most recent stock assessment, were provided via a website to the panel prior to the meeting (Appendix 1).

The meeting was structured with formal presentations covering an overview of Atka mackerel biology, fishery, assessment history, fishery-independent data, observer data, management, and assessment model. There were three CIE panel members in attendance as well as AFSC staff and industry representatives for part of the meeting. It was our understanding that the meeting had been well advertised but attendance was low, sometimes being limited to the CIE panelists, the assessment team and the chair. Martin Dorn chaired the meeting. Sandra Lowe and Jim Ianelli gave presentations as well as followed up on the panel's requests. Presentations were also given by AFSC staff: Craig Faunce, Tom Helser, Ned Laman, Susanne McDermott, and Stephani Zador. Delsa Anderl, Peter Munro and Chris Rooper attended for part of the meeting to answer any particular questions we had about their programs. Essentially, the members of the CIE panel functioned as the audience for the presentations and directed questions to the presenters and others in an informal setting. All of the panel's requests before, during and after the meeting were responded to quickly and completely.

Summary of Findings

Fishery independent data

Atka mackerel are monitored as part of the Aleutian Islands bottom trawl survey series that is now conducted biennially but had been conducted triennially prior to 2002 (note 2008 missing due to budget issues). The survey uses a stratified random design with 45 area-depth strata or subareas based on bathymetry and management area (von Szalay et al., 2011). Not all of the area is amenable to trawling and over time a pool of locations of successful tows has been developed to be used for choosing stations for the surveys. In 2002, the tow duration was changed to 15 minutes from the 20 to 30 minutes used from 1991 to 2000. This change resulted in a small increase in additional areas that tows could be made. Biomass and abundance estimates are calculated for the whole strata area assuming that mean density estimates for the trawlable areas also apply to the untrawlable areas.

The allocation of sampling stations to strata was based on a pseudo-Neyman allocation scheme. This scheme modifies the standard Neyman proportional plan of stratum area × stratum standard deviation by additionally assigning tows to strata proportional to abundance and current ex-vessel price across a range of species (14 species were referred to in the meeting). The first three factors were calculated from the five previous surveys of the area (von Szalay et al., 2011). Note that for many marine surveys, abundance estimates by strata are often correlated with standard deviation by strata and the use of both of these in the sample allocation plan may be redundant. The actual performance of this allocation scheme for providing more precise survey estimates does not appear to have been evaluated after the fact although there are methods available to do so (see Smith and Gavaris, 1993). Allocation of tows using multiple criteria will generally represent a compromise amongst competing criteria and species, and are unlikely to result in an optimum scheme for any one species (e.g., Appendix C, NRC 2000)

Atka mackerel are characterized as being difficult to survey using bottom trawls due to their preference for hard, rough and rocky bottom, schooling behavior, nesting behavior and changing accessibility to the trawl as a function of the tidal cycle (Lowe et al. 2013). The resulting annual survey estimates of biomass have large variances proportional to the biomass estimates with the eastern area (541 and South Bering Sea) being more variable than the central or western areas (Figure 17.4 Lowe et al., 2013). The eastern areas also exhibit higher annual changes in biomass than the central and western areas (Figure 1). The annual rate of change was calculated by solving for r in the following equation,

$$Biomass_t = Biomass_{t-k}(1+r)^k$$

where t is the current year and k is the time lag between the current and previous survey.

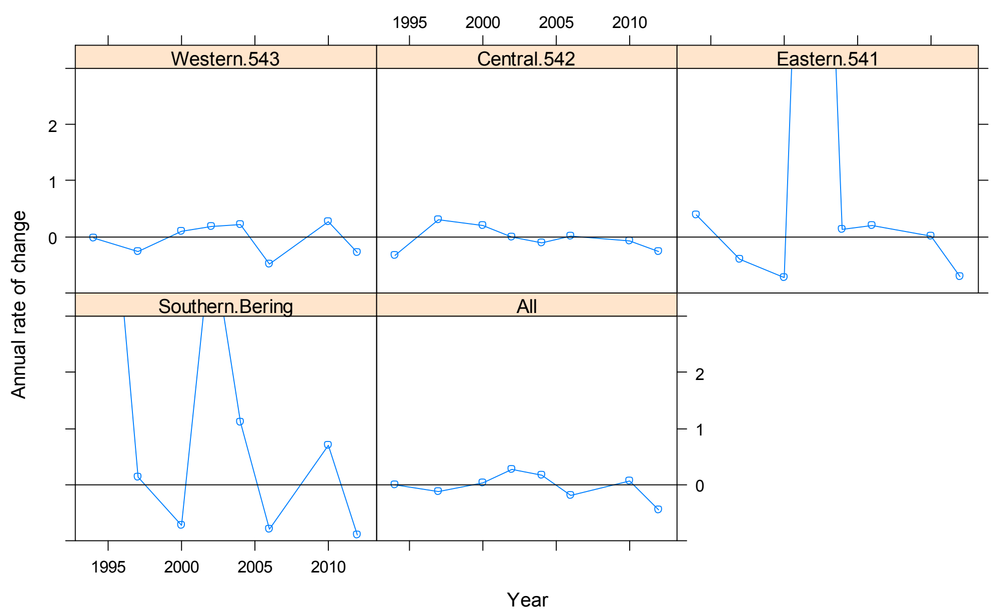

Figure 1. Annual rate of change (see text) for Atka mackerel survey estimates of biomass by subarea.

The survey data were further investigated during the meeting in terms of evaluating the impact of the design on the estimates and investigating the degree of patchiness of the catches. In the first case, the stratified CPUE was compared to the non-stratified mean over all observations (i.e., ignoring the strata) to see if the stratification used in the survey was effective at identifying areas of similar abundance. The small differences in the two survey trends suggest that strata had little relation to the distribution of Atka mackerel (Figure 2).

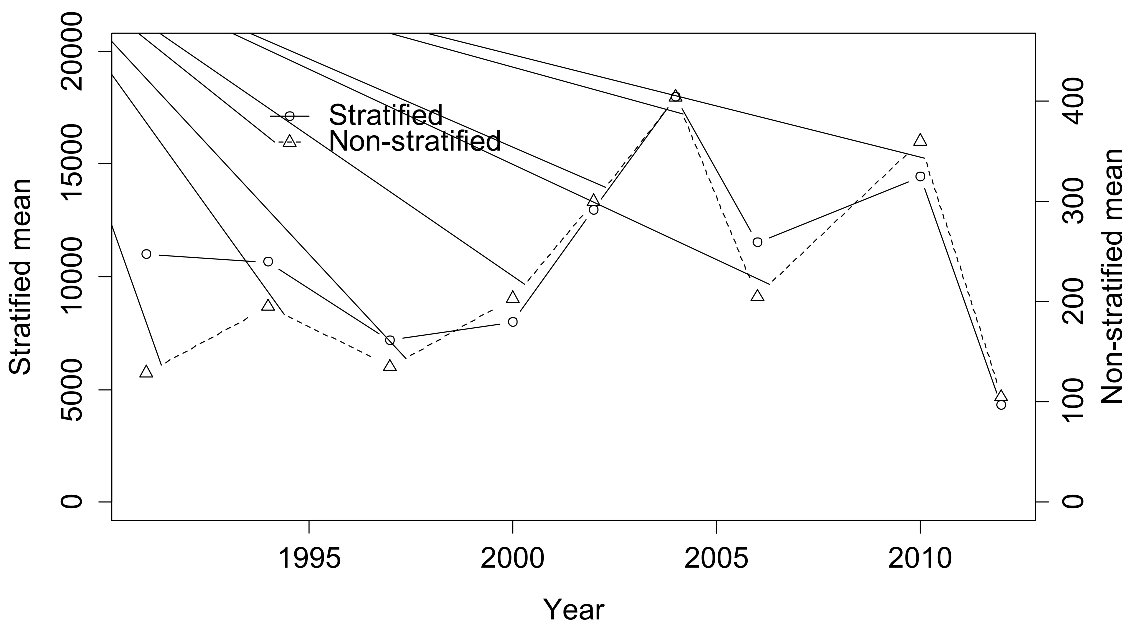

Figure 2. Comparison of stratified CPUE and non-stratified mean density (kg/km^2) for the Atka mackerel survey estimates.

The method used in Smith and Gavaris (1993) allows one to evaluate how well the strata contributed to any improvements in the precision of the mean or total estimates. There was not enough time or opportunity during the meeting to conduct this kind of analysis but the assessment team should consider conducting such an evaluation. From the results, one should be able to determine whether the strata are appropriate for capturing the distribution of this species and whether or not any gains can be made from adjusting the sample allocation scheme. Of course the latter aspect will have to be evaluated in conjunction with those for the other species caught in this survey.

Patchiness was investigated by comparing the annual trend for the proportion of non-zero tows with that for the survey CPUE (Figure 3). The two trends are parallel until the 2012 survey and both indicate increases after the 2000 survey. Given the change to the shorter tow duration in 2002 and thereafter, one would have expected a reduction in the encounter rate for a schooling species with a very patchy distribution resulting in a decline in the proportion of non-zero tows starting in 2002. However, discussions with the survey staff at the center suggested that the shorter tow durations allowed for access to more sites that may have been closer to mackerel habitat than was the case for the longer tows and hence could have resulted in an increase in the encounter rate.

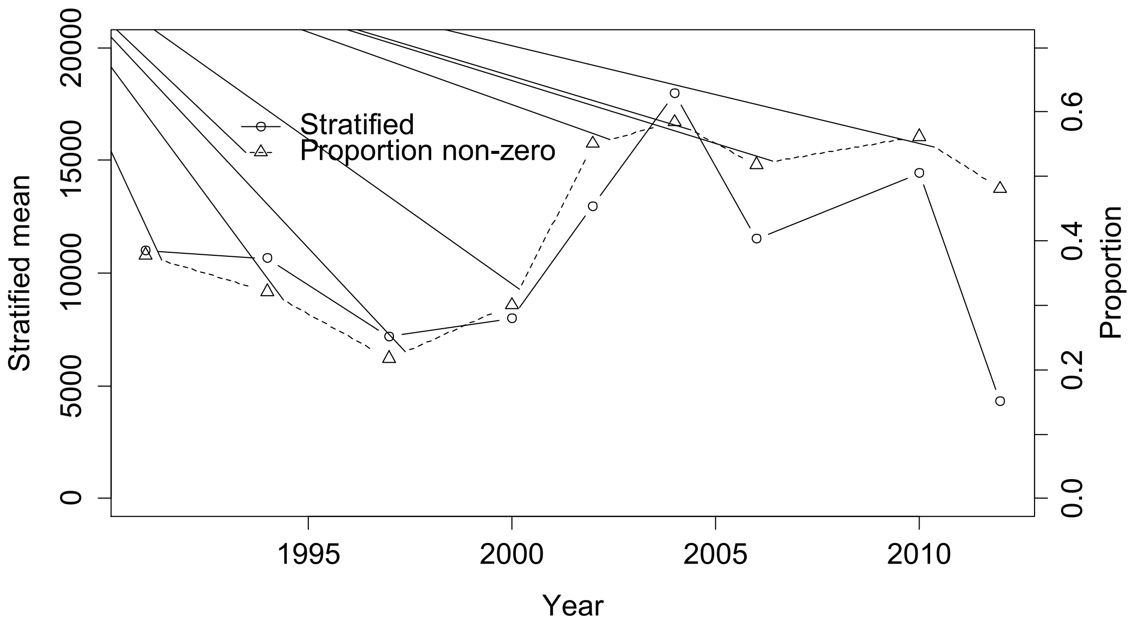

Figure 3. Comparison of the stratified CPUE and the proportion of non-zero tows for Atka mackerel from the survey.

A breakdown of non-zero tows by subarea indicating that the 2002+ effect was somewhat more predominate in the eastern part of the survey area, but all subareas showed the effect (Figure 4).

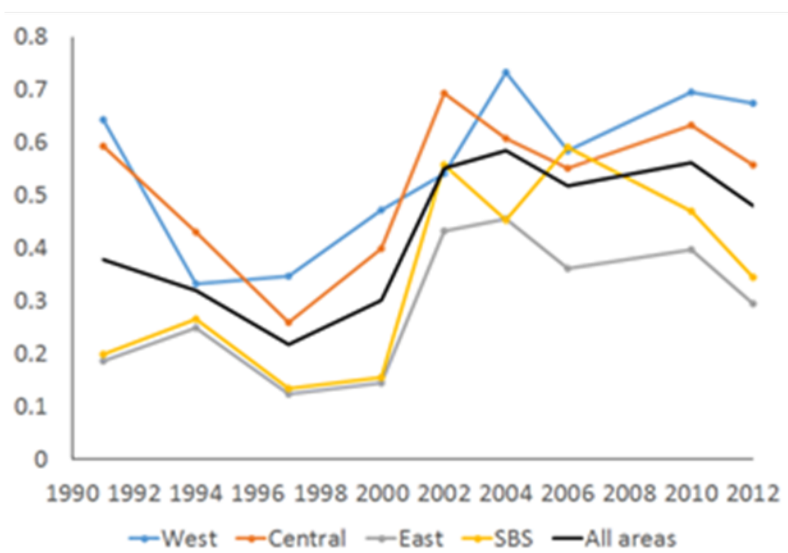

Figure 4. Proportion of non-zero survey tows for Atka mackerel by subarea.

The close association of the non-zero trend with that of the survey CPUE along with the suggestion that the change of shorter tow duration may have increased access of the survey to areas more likely to have Atka mackerel in them suggests that at a minimum, the 1991–2000 and 2002–2012 segments of the survey may not be comparable. As a consequence, the survey series may not be a consistent indicator of biomass or abundance trends for this species over the whole time series.

Fishery dependent data

Commercial CPUE estimates are not used in this assessment to monitor trends in abundance due to the many changes that have occurred over the time from when the foreign fishery was dominant to the most recent changes associated with closed areas, etc. The review did take a look at the available data to get a sense of the trends in these data along with the possible issues with using fishery dependent indices to track population biomass. Effort in terms of the duration of commercial tows was not immediately available and so catch-per-tow from bottom trawlers for catches where more than 80% of the catch was recorded as Atka mackerel were used to calculate CPUE by year and subarea (Figure 5).

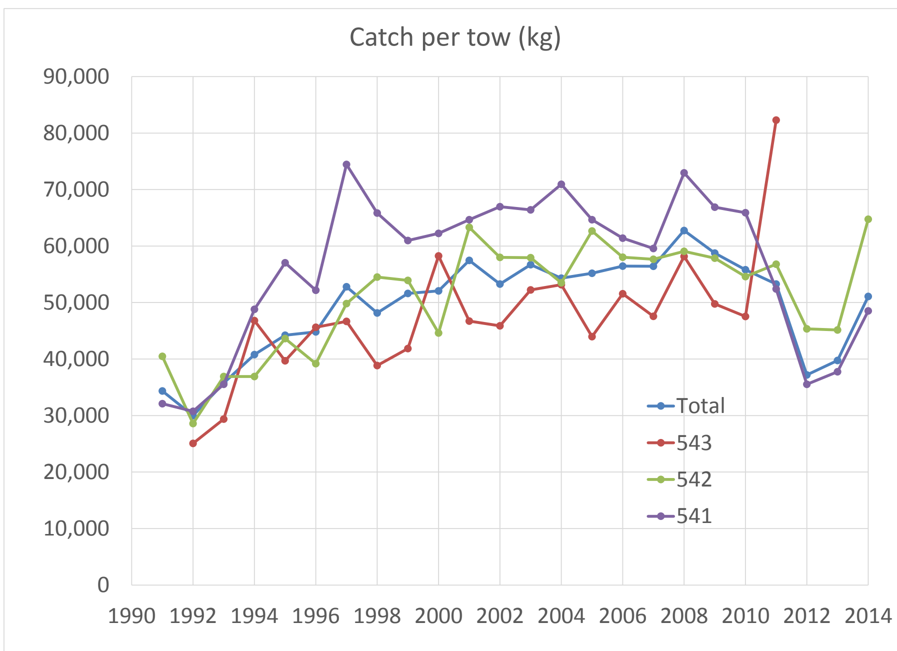

Figure 5. Atka mackerel catch-per-tow from commercial fishing collected by observers.

While the annual trends for the CPUE were broadly similar to those for the survey, there were irregularities that could not be explained in the meeting (e.g., CPUE for 543 in 2011 when the area was closed). Industry representatives at the meeting also reported that vessels had been capping their catch-per-tow at 50 t over the last few years to ensure quality, confounding the decline in catch rate for recent years. These data were not considered any further.

Incorporation of survey data in model

A lognormal prior with mean 1.0 and standard deviation on the log scale of 0.2 was set for the catchability for the survey (*q*) and the resulting posterior mean was 1.2. The patchy distribution of the species was suggested as the reason for *q* being higher than 1.0. However, the very close fit of the fishery age compositions by the model (Figure 17.11, Lowe et al., 2013) could also suggest that most of the trend information in the model was actually coming from the annual fishery age compositions and *q* was large to minimize the impact of the variable annual changes of the survey on the model.

The impacts of the survey estimates on the model fit were evaluated in the meeting in three ways. First, the survey index was down-weighted in the model by using a large CV for the survey likelihood component while retaining the original prior for *q*. This run resulted in nearly identical trends for the model estimates of biomass with lower estimates of biomass than the original run of the model. These results raised questions about the influence of the prior for *q* on the model and a second set of investigations were conducted where parameters for the prior were changed while using the original CV for the survey likelihood term. The input standard deviation (log scale) appears to have the larger impact on the posterior with *q* increasing to around 1.8 for the larger standard deviation used here (Table 1). The increase in *q* and the associated lower estimates of spawning stock biomass support the tendency of the model to minimize the annual changes of the survey index (Figure 6).

Table 1. Evaluation of the impact of different priors for *q* on the posterior estimates.

	Input	Input	Prior	**Results**		
Run	Median	sigma	Mean	ln *q*	Sigma lnq	*q*
Base	1.000	0.200	1.020	0.18212	0.210	1.199758
Run 2.2	0.741	0.800	1.020	0.58282	0.205	1.791082
Run 2.3	1.000	0.800	1.377	0.60206	0.200	1.825876

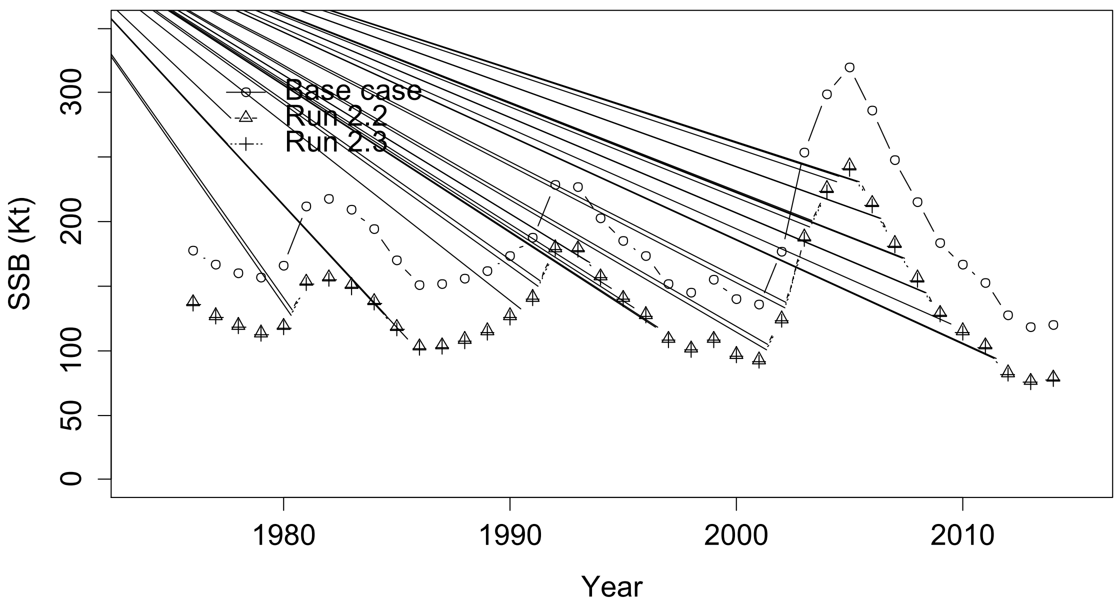

Figure 6. Spawning stock biomass (SSB) estimates from the base case model (model 2 in Lowe et al. 2013) and for changes to the prior on *q* to allow for a higher prior variance (Table 1).

Finally, an uncalibrated iterated cohort model was applied to the commercial catch-at-age during the meeting and resulting year-class estimates were compared with those from model 2 in Lowe et al. (2013). These results support the suggestion that most of the trend signal is coming from the fishery age compositions and not from the survey (Figure 7).

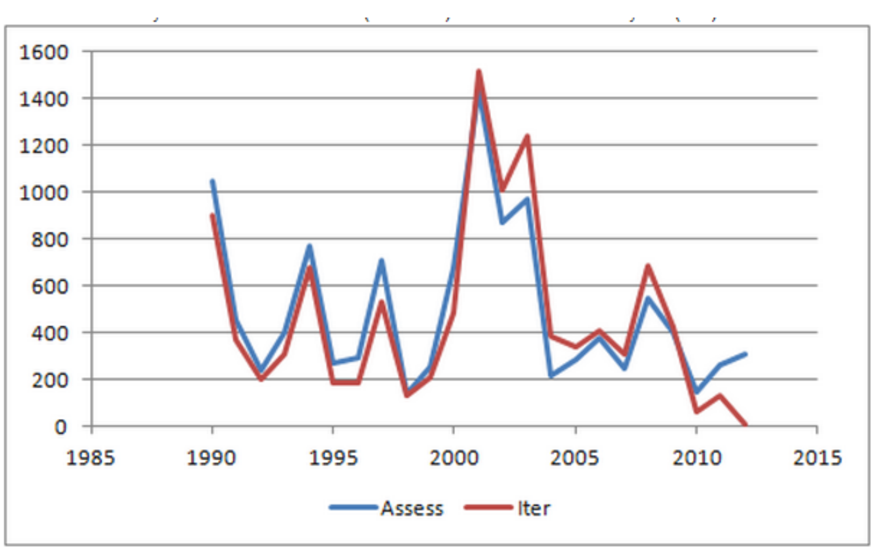

Figure 7. Comparison of results from model 2 with an iterated cohort analysis.

Population Dynamics

As discussed above, the annual survey indices may not be fully comparable with respect to population trend due to changes in tow duration. In addition, the model does not seem to use trend data from the surveys and instead model biomass estimates appear to reflect the very strong year-class signals in the age compositions in the catch. The use of penalized time-varying selectivity may result in the age compositions being even more influential as the selectivities indicate and possibly accentuate targeting on strong year-classes.

While having age compositions in the catch drive biomass trends in assessment models is not unusual, there is a concern here that even this source of trend information may not be consistent over time. The stock assessment is conducted over the whole area with separate subarea TACs broken out after the fact. Recent changes in management including the closure of subarea 543 and critical habitat areas in 542 have resulted in the catch information only representing Southern Bering Sea, 541 and a portion of 542 since 2011 (Figure 8).

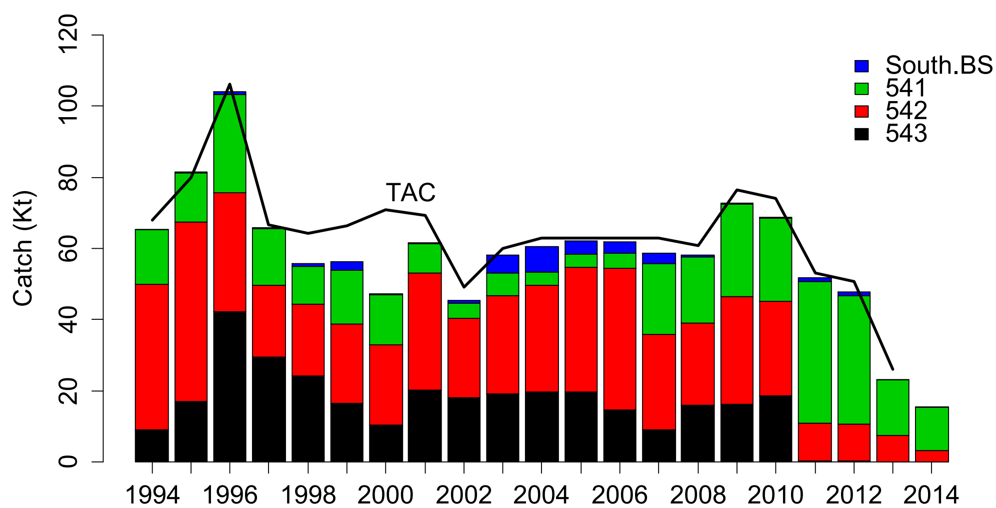

Figure 8. Catch by subarea of Atka mackerel.

Unless the age composition is similar over all subareas, the age compositions in the recent years no longer represent the entire stock area. Lowe et al. (2013) noted that the age compositions for the Southern Bering Sea also included fish from the neighboring area 519 (50 cm mode) so it is unlikely the current areas being fished are completely representative of the stock area age composition. Survey age compositions by subarea may provide some insight on possible consistencies over time.

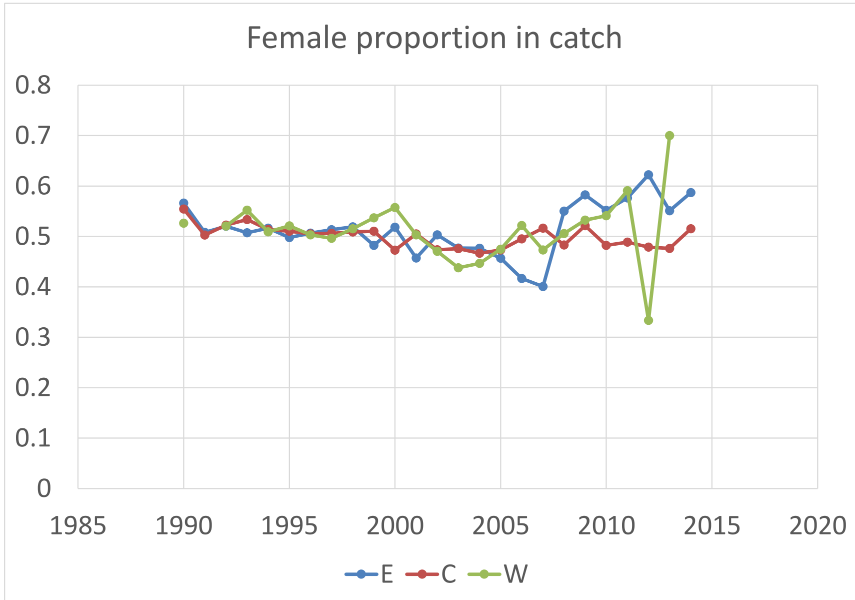

Figure 9. Proportion of females in the commercial catches of Atka mackerel based on observer data.

The population model estimates spawning stock biomass assuming a 50:50 sex ratio in the population. While this seems to be a reasonable assumption for the mid-1990s and for central area (542) over the times series, there has been an increasing trend in the eastern (541 and South Bering Sea) and western area since around 2006 (Figure 9). However, it is unclear what the sources of the estimates are for the western area starting in 2011 given that this area has been closed since the beginning of 2011. The impacts of changing sex ratio on biomass and recruitment estimates should be evaluated.

Selectivity

The 2008 CIE review recommended using separate fishery selectivity curves by time blocks corresponding to four different periods of the fishery in place of the time-varying selectivity curves that had been used (see Lowe et al. 2008). The main trend that these time blocks identified was the tendency for young fish being caught in the earlier periods (Foreign and Joint Venture) than in the more recent two periods (Figure 10).

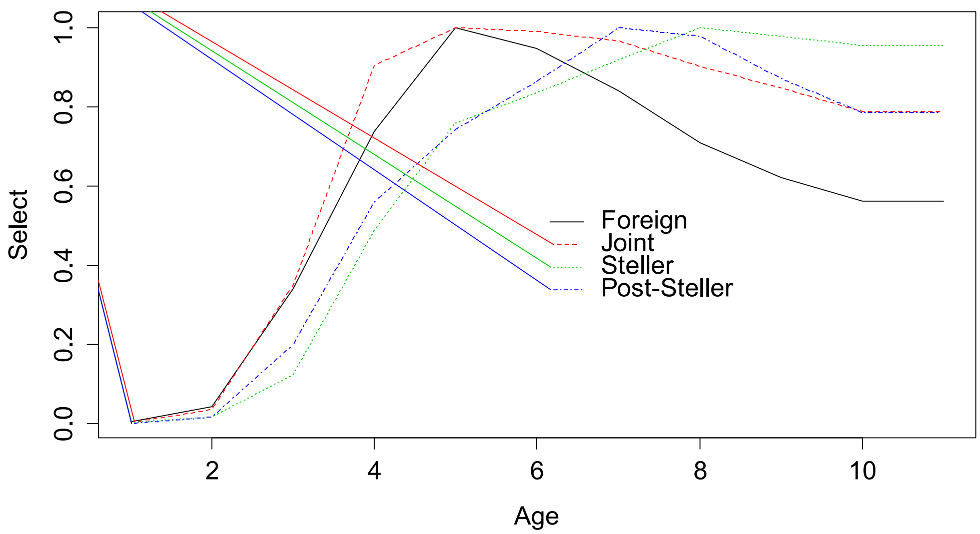

Figure 10. Selectivity curves for the four time blocks in the fishery used in Model 1 in Lowe et al. (2013). Foreign: 1977–1983, Joint Venture: 1984–1991, Steller: 1992–1998, Post-Steller: 1999–2013.

Both time block and constrained time-varying selectivity require subjective decisions to introduce a level of smoothing (Martell and Stewart 2014). While the time blocks chosen here may make some sense in the context of this fishery, they did not allow for targeting of strong year classes evident in the fishery age compositions. Allowing for time-varying selectivity will allow for targeting but unless constrained in some way could lead to the selectivity curves fitting very closely to the fishery age compositions implying that these compositions were known without error (similar to a VPA/cohort model). The approach adopted in this assessment was based on a non-parametric form that used penalty terms for time- and age-varying selectivity with former based on a random effects type approach and the latter on a function of the variance of successive differences. The resulting curves reflecting cohort tracking in the earlier history of the fishery while picking up on the shift to older ages in the more recent period (Figure 11.)

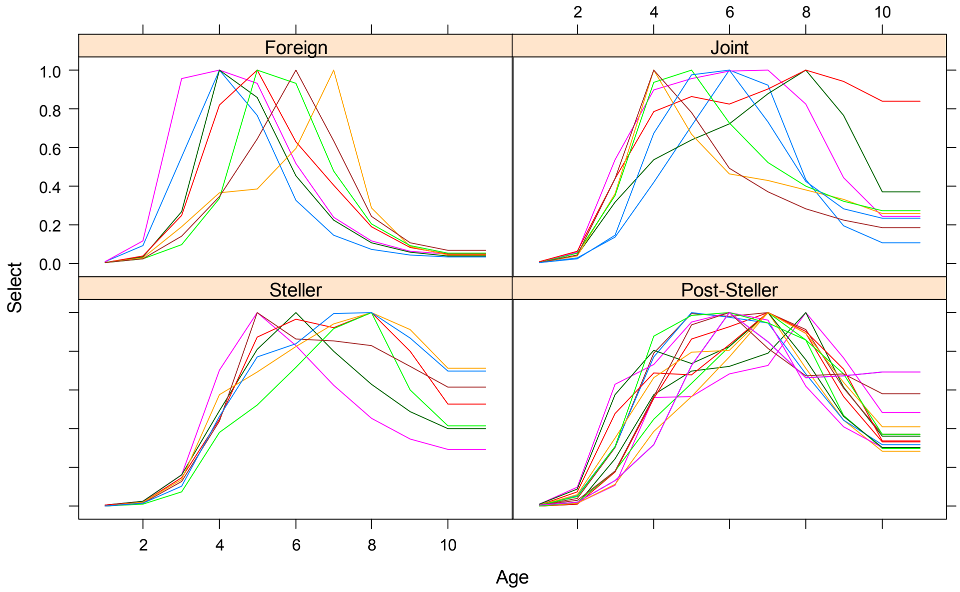

Figure 11. Time-varying selectivity curves used in Model 2 in their corresponding time blocks as used in Model 1 in Lowe et al. (2013). Foreign: 1977–1983, Joint Venture: 1984–1991, Steller: 1992–1998, Post-Steller: 1999–2013.

We reviewed the presentation from the 2013 CAPAM meeting (see Maunder et al. 2014) where the above approach was presented[1] but did not in the end come up many ideas for the assessment team to work on. They did produce some pairs-plots from MCMC runs to explore for possible relationships between the likelihood parameters and other parameters in the model but nothing conclusive was arrived at. Selectivities for a given year and the five-year mean used for projections from these same MCMC runs indicated variability between ages was higher than expected possibly reflecting Parma's observation in the 2008 review that smoothers may work fine for point estimates but may not behave that well over MCMC runs (reported by Francis (2008) and attributed to Parma). Steve Martell (IPHC) attended for a short time on the second day of the review and we very briefly discussed the spline approach used in Martell and Stewart (2014) which offer a possible alternative. In the end, it seemed that the time-varying method may not have been as constrained as expected and this may have been also indicated by the similarity of the results to that of the cohort analysis in Figure 7.

Apportionment by area

The TAC advice is developed for the stock area as a whole but the TAC is apportioned out by subarea after the fact using the mean percent biomass per subarea from the survey estimates over the previous four surveys. The surveys proportions by year are weighted with the largest weight (27) assigned to the most recent year with weights diminishing by 2/3 for each of the previous years. I am not sure why the weights were presented as whole integers given that they would have to be standardized to be between zero and one to estimate the weighted mean (i.e., 27/65).

[1] Unfortunately the paper associated with this presentation was not published with others from the CAPAM meeting in the special issue of Fisheries Research.

Lowe et al. (2013) referred to Lowe et al. (2001) for the background for this approach. In the latter document the use of the 2/3 factor was associated with the assumption that 2/3 of the total variability in predicting the biomass in the model was accounted for by the observation error associated with the surveys. It is not clear what estimates this assumption was based on exactly[2] but the 2001 assessment used stock synthesis and a much shorter survey series than is currently used in the current AMAK model. As a matter of course, this assumption should be updated with respect the current assessment model and survey time series.

A portion of a document was supplied to the panel during the meeting which compared exponential weighting and Kalman filtering (Attachment 2A: Estimation of Pacific Cod Biomass Distributions Based on Alternative Weightings of Trawl Survey Estimates) with the suggestion that under a number of conditions including that the biomass tends to follow a trendless random walk and the survey tends to be an unbiased estimator of biomass, both approaches result in equivalent weights. The formula for exponential weights given in the above document for year/survey $i=1,\ldots,4,$ was,

$$\theta_i = p(1-p)^{4-i}$$

Taking the ratio of θ_{i-1}/θ_i for any $i=2,\ldots,4$ and setting it equal to 2/3 results in p=1/3. Using this value for p to calculate θ_i for each i and standardizing by the sum of θ_i results in identical weights (when multiplied by 65) to those used in Lowe et al. (2013). However, the above document also suggests that the exponential rate parameter should be given by

$$p = \frac{2}{1+\sqrt{4r+1}}$$

where r is the ratio of observation error variance to process error variance. If the observation error was assumed to be 2/3 of the total error then r=2 in this case and p=0.5. There is a small difference between the smoothed proportion by subarea using an exponential weighting scheme with p=0.5 and the weights used in the current stock assessment (Figure 12). The increase in proportion of the total biomass in the Eastern area starting in 2002 may also reflect the increase in to access to areas where Atka mackerel are more likely to be caught because of the change to 15 minute tows.

[2] The text in Lowe et al. (2001) refers to an appendix in Lowe et al. (2000) but this latter report is not available on the online North Pacific Groundfish Stock Assessment Archives.

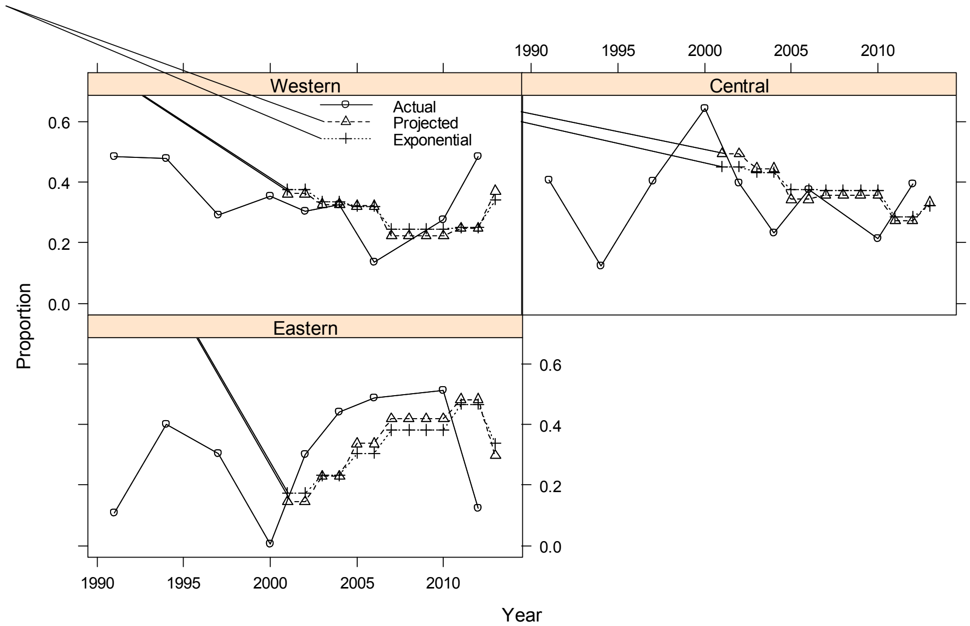

Figure 12. Comparison of the actual annual proportion of survey biomass by subarea with the smoothed projected proportion using weights in document (Projected) and exponential smoothing with p=0.5.

Natural Mortality

There was no work presented before the meeting to review on time or age-varying natural mortality. Some preliminary results were presented at the meeting where relationships between size and natural mortality similar to those given in Lorenzen (1996) were used. The impact of increasing the CV on the prior for natural mortality on the spawning stock biomass was also briefly considered.

Conclusions and Recommendations

The Atka mackerel fishery was modeled using the AMAK modeling approach, trawl survey data and catch composition information similar to many of the other species fisheries in the Alaska area. The modeling approach is well developed and has been successfully applied in other stock assessments. The trawl survey is designed according to highest standards, which is quite an achievement given the very large and difficult area that has to be covered. The catch data are comprehensive and accurate due to the very impressive observer program that is in place in Alaska.

Atka mackerel are acknowledged to be a difficult species to monitor using trawl surveys due to their behavior and the rocky habitat that they tend to be found in. It appears that the annual survey indices contribute little information in terms of trend based on the findings described above. In addition, the survey indices may not be helpful in scaling the catch information to the population because the survey q tends to increase to be much greater than 1.0 when the constraints on the associated prior are lessened. While it has been argued in Lowe et al. (2013) and in earlier documents that a q>1 makes sense for species exhibiting patchy distribution, the documents also state that the species prefers rocky bottom that is difficult to sample with a trawl, and may be higher in the water column at times due to the tidal cycle. These latter points suggest that there is a limited availability issue here and that the trawl survey may actually underestimate the biomass, suggesting that q should be less than 1.0. Given the very close fit of the model to the commercial age compositions, it is more likely that these data are providing the major trend signal and that the model naturally chooses larger values for q that minimize the inter and intra-annual variability of the survey estimates to correspond more closely to the commercial catch-at-age trends.

The TAC apportionment method relies on the survey estimates being unbiased estimates of population biomass. The validity of this assumption will be affected by issues identified above with the survey data.

As stated above having commercial catch-at-age estimates contributing strong annual trend information is neither unusual nor necessarily inappropriate, however the stock assessment models the stock over all subareas while the catch-at-age information is now mainly coming from only the eastern area and a part of the central area. Using time-varying and age specific selectivity can help to apportion fishing mortality accounting for changes in fishing practice and spatial effects but it was not clear if the penalties used were adequate enough to balance off signal and noise in the catch-at-age.

The main recommendations from my review of this stock assessment are:

1. Conduct a full evaluation of the survey data to understand the potential impact of the change in tow duration on the availability of Atka mackerel to the trawl survey. The adequacy of the survey design for the survey estimates and associated precision should also be evaluated to determine adequacy of the survey design for this species. Other approaches for analyzing the survey data such as spatial models, incorporating spatial covariates, especially those that are habitat related, into predictive estimates should be investigated. This latter approaches differs from the GAM-type of spatial models in that the survey design is retained in the estimation and the covariates are known for all locations not just the sampled locations (e.g., Royall 1988, Smith 1990, Singh et al. 2014).
2. Consider applying the AMAK model to each subarea separately. Atka mackerel do not appear to move very much once settled (McDermott et al. 2005). This approach will not improve the survey data per se, but it could offer some insights on whether or not survey indices provide better trend or scaling information when considered on a single area basis. This approach will also avoid the use of the survey data to apportion the catch. On the other hand, if the major portion of the trend information is still coming from the catch data, this approach will not be of much help in evaluating the impacts of opening up areas currently closed (i.e., Western).
3. Further evaluation of approach used to constrain the time and age-varying selectivities. It was unfortunate that we could not spend more time teasing out the behavior of this smoothing method but the MCMC runs suggested that there was more age-to-age variation than expected here.

Appendix 1: Bibliography of materials provided for review

Assessments

1. Lowe, S., J. Ianelli, W. Palsson. 2013. Stock assessment of Aleutian Islands Atka mackerel. In Stock Assessment and Evaluation Report for the Groundfish Resources of the Bering Sea/Aleutian Islands Regions. North Pacific Fisheries Management Council, P.O. Box 103136, Anchorage, Alaska, 99510. http://www.afsc.noaa.gov/REFM/Docs/2013/BSAIatka.pdf

2. Lowe, S., J. Ianelli, M. Wilkins, K. Aydin, R. Lauth, and I. Spies. 2008. Stock assessment of Aleutian Islands Atka mackerel. In Stock Assessment and Evaluation Report for the Groundfish Resources of the Bering Sea/Aleutian Islands Regions. North Pacific Fisheries Management Council, P.O. Box 103136, Anchorage, Alaska, 99510. http://www.afsc.noaa.gov/refm/docs/2008/BSAIatka.pdf

Sampling

3. Cahalan, J., Mondragon, J., and Gasper, J. 2010. Catch sampling and estimation in the Federal groundfish fisheries off Alaska. NOAA Technical Memorandum, NMFS-AFSC-: 42. Seattle. http://www.afsc.noaa.gov/Publications/AFSC-TM/NOAA-TM-AFSC-205.pdf.

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Biology

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Appendix 2: Statement of Work for Dr. Stephen Smith

External Independent Peer Review by the Center for Independent Experts

Bering Sea and Aleutian Islands Atka Mackerel Assessment

Scope of Work and CIE Process: The National Marine Fisheries Service's (NMFS) Office of Science and Technology coordinates and manages a contract providing external expertise through the Center for Independent Experts (CIE) to conduct independent peer reviews of NMFS scientific projects. The Statement of Work (SoW) described herein was established by the NMFS Project Contact and Contracting Officer's Representative (COR), and reviewed by CIE for compliance with their policy for providing independent expertise that can provide impartial and independent peer review without conflicts of interest. CIE reviewers are selected by the CIE Steering Committee and CIE Coordination Team to conduct the independent peer review of NMFS science in compliance the predetermined Terms of Reference (ToRs) of the peer review. Each CIE reviewer is contracted to deliver an independent peer review report to be approved by the CIE Steering Committee and the report is to be formatted with content requirements as specified in **Annex 1**. This SoW describes the work tasks and deliverables of the CIE reviewer for conducting an independent peer review of the following NMFS project. Further information on the CIE process can be obtained from *www.ciereviews.org*.

Project Description: The Alaska Fisheries Science Center (AFSC) requests a Center of Independent Experts (CIE) review of the Bering Sea and Aleutian Islands stock assessment for Atka mackerel. In the Aleutian Islands Atka mackerel are a key prey for several top trophic level consumers in the region. Of particular concern, Atka mackerel are a dominant prey item for the endangered Steller sea lion. In addition, Aleutian Islands Atka mackerel supports a valuable commercial fishery. In 2011, large scale changes to the Atka mackerel fishery were imposed as protection measures for Steller sea lions. These measures included large area closures and reduction in directed fishing quotas. Currently the Atka mackerel fishery is closed in the western Aleutians (representing about 34% of the quota). Because of their unique role in the Aleutian Island ecosystem and their importance to industry, reliable estimates of Atka mackerel biomass and trends are needed to provide informed catch recommendations. Several changes have been made to improve the assessment since the last CIE review. Recent model explorations have focused attention on alternative approaches to specifying selectivity, natural mortality, and age-specific survey catchability. We will be seeking advice on incorporating alternative approaches for the estimation of these key parameters. The Terms of Reference (ToRs) of the peer review are attached in **Annex 2**.

Requirements for CIE Reviewers: Three CIE reviewers shall have the necessary qualifications to complete an impartial and independent peer review in accordance with the tasks and ToRs described in the SoW herein. The CIE reviewers shall have expertise in conducting stock assessments for fisheries management, and be thoroughly familiar with various subject areas involved in stock assessment, including population dynamics, separable age-structured models, harvest strategies, survey methodology, and the AD Model Builder programming language to complete the tasks of the scientific peer-review described herein. Each CIE reviewer is requested to conduct an impartial and independent peer review in accordance with the ToRs herein. The CIE reviewer's duties shall not exceed a maximum of 14 days conducting pre-review preparations with document review, participation in the panel review meeting, and completion of the CIE independent peer review report in accordance with the ToR and Schedule of Milestones and Deliverables.

Location of Peer Review: Each CIE reviewer shall participate and conduct an independent peer review during the panel review meeting scheduled at the Alaska Fisheries Science Center (AFSC) in Seattle, Washington during the dates of July 29-31, 2014.

Statement of Tasks: Each CIE reviewer shall complete the following tasks in accordance with the SoW and Schedule of Milestones and Deliverables herein.

Tasks prior to the meeting: The contractor shall independently select qualified reviewers that do not have conflicts of interest to conduct an independent scientific peer review in accordance with the tasks and ToRs within the SoW. Upon completion of the independent reviewer selection by the contractor's technical team, the contractor shall provide the reviewer information (full name, title, affiliation, country, address, email, and FAX number) to the contractor officer's representative (COR), who will forward this information to the NMFS Project Contact no later than the date specified in the Schedule of Milestones and Deliverables. The contractor shall be responsible for providing the SoW and stock assessment ToRs to each reviewer. The NMFS Project Contact will be responsible for providing the reviewers with the background documents, reports, foreign national security clearance, and other information concerning pertinent meeting arrangements. The NMFS Project Contact will also be responsible for providing the Chair a copy of the SoW in advance of the panel review meeting. Any changes to the SoW or ToRs must be made through the COR prior to the commencement of the peer review.

Foreign National Security Clearance: The reviewers shall participate during a panel review meeting at a government facility, and the NMFS Project Contact will be responsible for obtaining the Foreign National Security Clearance approval for the reviewers who are non-US citizens. For this reason, the reviewers shall provide by FAX (not by email) the requested information (e.g., first and last name, contact information, gender, birth date, passport number, country of passport, travel dates, country of citizenship, country of current residence, and home country) to the NMFS Project Contact for the purpose of their security clearance, and this information shall be submitted at least 30 days before the peer review in accordance with the NOAA Deemed Export Technology Control Program NAO 207-12 regulations available at the Deemed Exports NAO website: http://deemedexports.noaa.gov/.

Pre-review Background Documents: Approximately two weeks before the peer review, the NMFS Project Contact will provide copies of stock assessment documents, survey reports, and other pertinent literature on a web site for the reviewers to conduct the peer review, and the COR will forward these to the contractor. The reviewers are responsible only for the pre-review documents that are delivered to the contractor in accordance to the SoW scheduled deadlines specified herein. The reviewers shall read all documents deemed as necessary in preparation for the peer review.

Tasks during the panel review meeting: Each reviewer shall conduct the independent peer review in accordance with the SoW and stock assessment ToRs, and shall not serve in any other role unless specified herein. **Modifications to the SoW and ToRs shall not be made during the peer review, and any SoW or ToRs modifications prior to the peer review shall be approved by the COR and contractor.** Each reviewer shall actively participate in a professional and respectful manner as a member of the meeting review panel, and their peer review tasks shall be focused on the stock assessment ToRs as specified herein. The NMFS Project Contact will be responsible for any facility arrangements (e.g., conference room for panel review meetings or teleconference arrangements). The NMFS Project Contact will also be responsible for ensuring that the Chair understands the contractual role of the reviewers as specified herein. The contractor can contact the COR and NMFS Project Contact to confirm any peer review arrangements, including the meeting facility arrangements.

Tasks after the panel review meeting: Each reviewer shall prepare an independent peer review report, and the report shall be formatted as described in **Annex 1**. This report should explain whether each stock assessment ToR was or was not completed successfully during the panel review meeting. Additional questions and pertinent information related to the assessment review addressed during the meetings that were not in the ToRs may be included in a separate section at the end of an independent peer review report.

The chairperson shall generate a Summary Report that compiles the points made by the three individual reviewers into one succinct document. The individual reports shall be appended to the Summary Report, thereby providing the complete detailed information from the individual reviewers.

Contract Deliverables - Independent CIE Peer Review Reports: Each CIE reviewer shall complete an independent peer review report in accordance with the SoW. Each CIE reviewer shall complete the independent peer review according to required format and content as described in Annex 1. Each CIE reviewer shall complete the independent peer review addressing each ToR as described in Annex 2.

Specific Tasks for CIE Reviewers: The following chronological list of tasks shall be completed by each CIE reviewer in a timely manner as specified in the **Schedule of Milestones and Deliverables**.

1) Conduct necessary pre-review preparations, including the review of background material and reports provided by the NMFS Project Contact in advance of the peer review.

2) Participate during the panel review meeting at Seattle, Washington during July 29-31, 2014.
3) Conduct an independent peer review in accordance with the ToRs (**Annex 2**).
4) No later than August 15, 2014, each CIE reviewer shall submit an independent peer review report addressed to the "Center for Independent Experts," and sent to Mr. Manoj Shivlani, CIE Lead Coordinator, via email to shivlanim@bellsouth.net, and CIE Regional Coordinator, via email to Dr. David Die at ddie@rsmas.miami.edu. Each CIE report shall be written using the format and content requirements specified in Annex 1, and address each ToR in **Annex 2**.

Schedule of Milestones and Deliverables: CIE shall complete the tasks and deliverables described in this SoW in accordance with the following schedule.

23 June 2014	CIE sends reviewer contact information to the COR, who then sends this to the NMFS Project Contact
7 July 2014	NMFS Project Contact sends the stock assessment report and background documents to the CIE reviewers.
29-31 July 2014	Each reviewer shall conduct an independent peer review during the panel review meeting in Seattle, Washington
15 August 2014	CIE reviewers submit draft CIE independent peer review reports to the CIE Lead Coordinator and CIE Regional Coordinator
29 August 2014	CIE submits CIE independent peer review reports to the COR
5 September 2014	The COR distributes the final CIE reports to the NMFS Project Contact and regional Center Director

Modifications to the Statement of Work: This 'Time and Materials' task order may require an update or modification due to possible changes to the terms of reference or schedule of milestones resulting from the fishery management decision process of the NOAA Leadership, Fishery Management Council, and Council's SSC advisory committee. A request to modify this SoW must be approved by the Contracting Officer at least 15 working days prior to making any permanent changes. The Contracting Officer will notify the COR within 10 working days after receipt of all required information of the decision on changes. The COR can approve changes to the milestone dates, list of pre-review documents, and ToRs within the SoW as long as the role and ability of the CIE reviewers to complete the deliverable in accordance with the SoW is not adversely impacted. The SoW and ToRs shall not be changed once the peer review has begun.

Acceptance of Deliverables: Upon review and acceptance of the CIE independent peer review reports by the CIE Lead Coordinator, Regional Coordinator, and Steering Committee, these reports shall be sent to the COR for final approval as contract deliverables based on compliance with the SoW and ToRs. As specified in the Schedule of Milestones and Deliverables, the CIE shall send via e-mail the contract deliverables (CIE independent peer review reports) to the COR (William Michaels, via William.Michaels@noaa.gov).

Applicable Performance Standards: The contract is successfully completed when the COR provides final approval of the contract deliverables. The acceptance of the contract deliverables shall be based on three performance standards:
(1) The CIE report shall completed with the format and content in accordance with **Annex 1**,
(2) The CIE report shall address each ToR as specified in **Annex 2**,
(3) The CIE reports shall be delivered in a timely manner as specified in the schedule of milestones and deliverables.

Distribution of Approved Deliverables: Upon acceptance by the COR, the CIE Lead Coordinator shall send via e-mail the final CIE reports in *.PDF format to the COR. The COR will distribute the CIE reports to the NMFS Project Contact and Center Director.

Support Personnel:

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Key Personnel:

NMFS Project Contact:

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Annex 1: Format and Contents of CIE Independent Peer Review Report

1. The CIE independent report shall be prefaced with an Executive Summary providing a concise summary of the findings and recommendations, and specify whether the science reviewed is the best scientific information available.

2. The main body of the reviewer report shall consist of a Background, Description of the Individual Reviewer's Role in the Review Activities, Summary of Findings for each ToR in which the weaknesses and strengths are described, and Conclusions and Recommendations in accordance with the ToRs. The CIE independent report shall be a stand-alone document for others to understand the weaknesses and strengths of the science reviewed. The CIE independent report shall be an independent peer review of each ToRs.

3. The reviewer report shall include the following appendices:

   Appendix 1: Bibliography of materials provided for review
   Appendix 2: A copy of the CIE Statement of Work

Annex 2: Terms of Reference for the Peer Review

Bering Sea and Aleutian Islands Atka Mackerel Assessment

All reports shall address the following points.

(1) The strengths and weaknesses of the modeling efforts for the Bering Sea and Aleutian Islands Atka mackerel assessment and harvest recommendations. Specifically, the review shall evaluate:
   - The analysts' use of fishery dependent and fishery independent data sources in the assessments;
   - Gaps or inconsistencies in the population dynamics modeling methodology or logic;
   - How assessment uncertainties may best be applied for management advice; and
   - Whether the assessments provide the best available science.

Additionally, the review shall (to the extent practical) evaluate and provide advice on:

(2) The specification of time-varying and age-specific selectivity parameters

(3) The treatment and application of survey data; specifically

   - Survey biomass estimates by management areas as used for quota apportionments; this stock forms dense patchy schools resulting in high variability

   - Survey catchability

(4) The incorporation of age differential natural mortality and the interaction with selectivity and survey catchability parameters

The AFSC will provide copies of stock assessment documents, survey reports, and other pertinent literature on a web site.

Annex 3: Agenda for

CIE Bering Sea/Aleutian Islands Atka mackerel Stock Assessment Review

NMFS Alaska Fisheries Science Center
7600 Sand Point Way NE, Building 4, **Room 2039,** Seattle, Washington

Article I. AGENDA *JULY 8 VERSION* July 29-31, 2014

Tuesday July 29th

9:00	Welcome and Introductions	**Martin Dorn (Chair)**
9:15	**Overview** (management, fishery, biology descriptions)	
	Management control rules and general modeling approach	**Jim Ianelli**
	Atka mackerel fishery and life history	**Sandra Lowe**
10:30	*Break*	
10:45	**Observer** sampling and coverage (1 hr)	**FMA TBD**
11:45	***Lunch***	
13:00	**Age and growth** (1 hr)	**Age and Growth TBD**
14:00	**Bottom trawl survey** (1 hr)	**Ned Laman, Susanne McDermott**
15:00	*Break*	
15:15	Aleutian Islands **ecosystem** overview (45 min)	**Stephani Zador**
16:00	Assessment model (AMAK) details	
17:00	Meeting adjourns for the day	

Note *At the end of each presentation and after the panel has had an opportunity for questions, we will solicit brief public comment and questions as moderated by the Chairperson*

Wednesday July 30th

9:00	Atka Mackerel stock assessment	**Sandra/Jim**
10:45	*Break*	
11:00	Review of stock assessment issues: incorporation of uncertainty, time-varying and age-specific selectivity, survey estimates by management area as used for quota apportionments, survey catchability, age differential *M* and interactions with selectivity and survey catchability parameters	
12:00	*Lunch*	
13:00	Discussion of proposed assessment model changes	
15:00	Meeting adjourns for the day (afternoon reserved to work on model runs)	

Thursday July 31st

9:00	Evaluation of alternative model configurations	
	Reviewer discussions with assessment authors	
12:00	***Lunch***	
1:00	Reviewer discussions with assessment authors as needed (continued)	
3:00	Report writing. AFSC analysts will be available to respond to requests and answer questions	